Mars Network: A Telecommunications and Navigation Network for Future Mars Exploration

C. Edwards, J. Adams, Y. Bar-Sever, D. Bell, R. Cesarone,
T. Ely, D. Lehman, K. Leschly, S. Rosell, J. Srinivasan, S. Townes

Jet Propulsion Laboratory, California Institute of Technology
Pasadena, CA, USA

Abstract

The coming decade of international Mars exploration encompasses a diverse set of challenging missions, including highly capable landers, rovers, microprobes, and aerobots, and involving complex operations to support in situ science as well as return of scientifically selected samples to Earth. This aggregate mission set poses increased demands for telecommunications and navigation relative to current capabilities. Specific challenges include: high-rate telemetry suppport for critical mission events such as entry, descent, and landing; high-accuracy approach navigation to support aerocapture and precision landing scenarios; increased communications bandwidth and connectivity to support complex surface operations; efficient relay communications for energy-constrained microlanders; tracking of Mars ascent vehicles and in-orbit sample canisters, and navigation support for rendezvous and docking.

To support these needs, NASA is developing plans for a Mars Network, a constellation of Mars-orbiting satellites providing telecommunications and navigation services to future Mars missions. Specific elements of the Mars Network include low-cost microsatellites and larger Mars Areostationary Relay Satellites (MARSATs). The microsatellites, launched as secondary payloads on Ariane 5 commercial launches, can be deployed in an evolving constellation of low-altitude orbiters. A six-satellite constellation would provide global coverage to any point on Mars, with hourly contact to low-latitude landers, multi-gigabit data return per sol, and radio-based position determination of surface assets at an accuracy of 10 m. MARSAT would complement the low-altitude microsatellites by providing continuous visibility of one hemisphere of the planet, and would support extremely high data rates, enabling near-continuous streaming video from the surface of Mars. Such capabilities would truly begin to enable NASA's strategic goal of creating a virtual presence throughout the solar system.

In this paper we will summarize the needs of the currently planned Mars exploration mission set, outline design trades and options for meeting these needs, and quantify the specific telecommunications and navigation capabilities of an evolving Mars Network.